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Analysis of Pesticide-Related Illnesses of Select Mixer/Loader/Applicators for Years 1994 and 1998

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Abstract

As part of United States Environmental Protection Agency's (USEPA) evaluation of the federal Worker Protection Standard (WPS), the California Department of Pesticide Regulation's Worker Health and Safety (WHS) Branch performed an analysis of mixer/loader/applicator (MLA) illness and injury investigations in which no contributory violations had been found.

A subset of the Pesticide Illness Surveillance Program (PISP) database, concerning MLA's engaged in agricultural production, was analyzed for certain select criteria, including personal protective equipment use, type of injury, activity during injury, existence of any engineering controls, target crop, pesticide(s) implicated, and general circumstances possibly related to exposure. In order to compare the effects of federal WPS implementation, the years chosen for analysis were pre-WPS (1994) and post-WPS (1998). Analysis focused on 72 cases in 1994 and 62 cases in 1998.

The pesticides glyphosate, sulfur, metam-sodium, and propargite had the greatest frequency of pesticide illness and injury association. Some of the illnesses and injuries could be clearly identified with equipment problems or operator error. Proper use of personal protective equipment (from lack of training or incorrect use) was also suspect. The San Joaquin Valley region had the largest number of cases in both surveyed years. An assessment of crops treated showed that grapes were the crop most associated with MLA illnesses in both years also.

A potential confounding factor to the analysis was California's pre-existing worker safety regulations. These regulations have been developed and implemented in California since the late 1970's and closely parallel the federal WPS. Essentially, California has had a functional state WPS program for pesticide applicators for many years prior to the federal WPS.

This study found no discernible effect of the federal WPS on the number of MLA illnesses and injuries, comparing 1994 to 1998. This is not an unreasonable outcome, given that California has had a state-level WPS in place previous to the introduction of the federal program.

Introduction

As part of United States Environmental Protection Agency's (USEPA) evaluation of the federal Worker Protection Standard (WPS), the California Department of Pesticide Regulation's Worker Health and Safety (WHS) Branch performed an analysis of mixer/loader/applicator (MLA) illness and injury investigations in which no contributory violations had been found. This analysis was made to determine if implementation of the WPS had any effect on the number of MLA pesticide-related illness/injuries reported to WHS.

The WPS is a regulation issued by USEPA that requires pesticide handlers and agricultural workers who may be exposed to pesticides or their residues to be provided with the following:

1. Information about exposure to pesticides.
2. Protections against exposure to pesticides.
3. Ways to mitigate exposures to pesticides.

In California, information on pesticide-related illnesses and injuries are collected and documented in a database by the Pesticide Illness Surveillance Program (PISP) of WHS. Medical reports are received from physicians and Workers' Compensation records. The local county agricultural commissioner (CAC), which CAC conducts inspections of agricultural worksites and enforces pesticide regulations, also investigates circumstances of each reported exposure. The medical records and investigative findings from the CAC are recorded into an illness database. These data are used primarily to determine trends in illness and injury produced by a particular pesticide or activity. PISP provided the data set from which this analysis was drawn[1].

Methods

Selection Criteria

A subset of the PISP database, concerning MLA's engaged in agricultural production, was analyzed for certain select criteria, including personal protective equipment use, type of injury, activity during injury, existence of any engineering controls, target crop, pesticide(s) implicated, and general circumstances possibly related to exposure. These cases were also classified by PISP as having a strong likelihood of pesticidal involvement in the illness/injury. These cases were classified under the PISP association coding of "Definite", "Probable" and "Possible" relationship of illness/injury to pesticide exposure. Other association codings used by PISP (and which were preemptively excluded from consideration, given the uncertainty that pesticides were involved in the illness/injury) included "Unlikely", "Unrelated" and "Not Applicable" designations.

Within the PISP data set, there were several MLA illnesses and injuries: 129 in 1994 and 105 in 1998. These numbers included cases where violation(s) of existing pesticide regulations contributed to the cause of illness/injury. Cases where violations were considered contributory to the illness/injury were removed from analysis. Two assumptions were made in removing these MLA cases from analysis:

1. Cases with contributory violations show lack of regulatory compliance; illness/injury occurred because one or more safety regulations were not followed. It is assumed that any new regulations introduced under WPS would be equally violated if they were perceived by the MLA to be unnecessary or interfere with the MLA's work procedures. Therefore cases with contributory violations were not analyzed.

2. Cases with no or non-contributory violations would be most likely to reflect the effect of WPS implementation by showing a decrease in number from pre- to post-implementation. New safety conditions imposed on worksites by the WPS should address hazardous conditions previously unmitigated. The introduction of new safety regulations to workplaces should result in less workplace injury/illness if the new regulations are followed and if the new regulations address unsafe conditions previously unregulated.

The selection of MLAs for this study was to investigate if an effect was apparent via a change in MLA illness numbers. The source of MLA illnesses and injuries are more easily identifiable, in terms of causation analysis, than other types of workers who may be covered by the WPS, such as harvesters. With MLAs, an identifiable hazardous material is usually either noted to have direct contact with the worker or at least be in proximity to the worker. With harvesters, unless residue samples are taken, the connection to hazardous material source is much more tenuous. A cause and effect relationship is much more difficult to establish if there is no information on the level of the exposure source. Moreover, we were looking at cases where no violations occurred, yet the MLA still became injured. If we applied this criterion to other field workers, (no violation yet illness) it would be all but impossible, lacking field residue data, to establish what caused the worker injury. Indeed, Dr. Michael O'Malley points out, in "Pesticide Dermatoses[2]" that "The degree of exposure to pesticide residues depends upon the initial application rate, the half-life of residue dissipation, the nature of the crop, and the nature and timing of the work performed." Also, as Dr. O'Malley contended in a 1987 Kern County dermatitis outbreak, even with DFR data, "It was not possible to conclude which compound may have been the principle cause of the outbreak." (ibid.). Therefore, given the greater potential for certainty in the standard industrial hygiene "Source to Pathway to Receiver" formula, MLAs were considered a good candidate for WPS effect analysis.

In order to compare the effects of WPS implementation, the years chosen for analysis were pre-WPS (1994) and post-WPS (1998). Strictly speaking, national compliance with the WPS was required on April 15, 1994. However, the field safety aspects of the WPS were not implemented at the federal level until January 1, 1995. Full federal WPS implementation was not accomplished until 1996. The reason for the selection of 1994 and 1998 was to compare pre- and post-implementation illness/injury rates for MLAs. The pre-WPS year of 1994 was selected because it was prior to full field implementation in California. The post-WPS year 1998 was selected because the federal WPS should have been fully implemented, with all the necessary training and grower/worker education in place. Though neither time period is in any way special, other than for the reason just cited, 1994 is probably the latest pre-WPS year one could use and still expect federal WPS effects to be minimal. Data from 1995 and especially from 1996 on, would be "tainted" by the implementation of the federal WPS. Data from before 1994, though unaffected by the federal WPS, would tend to amplify confounding factors. Changes in pesticide availability, PPE technology, application equipment technology, and crop trends will tend to distort pre/post comparisons of the federal WPS. For example, mevinphos' was canceled in

1995, which would influence the number of illnesses pre- and post-WPS. So the selection of 1994 allows for the closest pre-WPS time period, minimizing systemic changes in the study environment.

Furthermore, a potential confounding factor to the analysis is California's pre-existing worker safety regulations. These regulations have been developed and implemented in California since the late 1970's and closely parallel the WPS. Essentially, California has had a functional state WPS program for pesticide applicators for many years prior to the federal WPS.

Case Analysis

Of the illness cases with no violation noted, there were 81 MLA cases for 1994, 75 cases for 1998. Nine cases were removed from 1994 and 13 cases were removed from 1998 since they dealt with the use of disinfectants and sanitizers (sodium hypochlorite and quaternary ammonia), the use of gaseous fumigants not within the purview of the WPS (methyl bromide, sulfur dioxide, propylene oxide and ethylene oxide) or were part of a task, subsumed by regulation, inappropriate for this MLA case analysis (methyl bromide tarp-sealing shovelers, though part of the application crew, are not truly applicators). These materials and their use fall outside the scope of this data analysis. This leaves 72 cases in 1994 and 62 cases in 1998.

Results

Illness Type

Information concerning the type of illness and/or injury is presented in Table One. **EYE** related injuries were largely reported as irritation, redness, burning sensation, pain and blurred vision. **SKIN** injuries were most often listed as rashes, chemical burns, itching sensation, dermatitis and reddening. **SYSTEMIC** illnesses ("poisoning") were usually reported involving nausea, headache, vomiting, shortness of breath, flu-like feeling, nose/throat/mouth irritation, general weakness, and dizziness. When multiple illness/injury types were noted, the most serious effect, using the descending hierarchy of systemic>eye>skin, was considered definitive for the case (i.e. a case with both an eye injury and systemic illness effects would be considered, for purposes of this analysis, a systemic illness).

The relationship of personal protective equipment (PPE) to the site of illness/injury is also given in Table One. In the cases of both **SYSTEMIC** and **SKIN**, either a route was established (worker noted material on unprotected body part) or the route was unknown (worker does not know how or where material came into contact with their body). In the unique case of **EYE** injury, a worker could reasonably be assumed to know their eye protection status (on/protected or off/unprotected). The nature of eye protective PPE varies (goggles are surface sealing, safety glasses and face shields are vulnerable to "floating" particulates and splashing liquids circumventing the non-sealing protective surfaces).

Table One: Type of Illness/Injury Related to Route of Exposure

Illness/injury site and probable cause	1994	1998
EYE (irritation/redness/swelling/blurring) ***Overall Totals***	***20***	***18***
Goggles reported *WORN*	7	1
Goggles required but reported *OFF* [a]	0	4
Safety Glasses reported *WORN*	3	7
Face Shield reported *WORN*	3	4
Eye Protection not supposedly required [b]	7	2
SKIN (rash/chemical burn/dermatitis/itching) ***Overall Totals***	***26***	***24***
Established exposure route (skin not protected or material noted on skin)	10	7
Route unknown/unestablished [c]	16	17
SYSTEMIC (nausea/headache/breathing problems/vomiting/etc.) ***Overall Totals***	***26***	***20***
Established exposure route (noted odor and/or dermal exposure)	9	14
Route unknown/unestablished [c]	17	6

[a] Either had removed required goggles to rub eyes or had removed between ML operations.

[b] Unclear from report as to whether eye protection was required.

[c] Worker could not identify route of exposure/did not recall any potential exposure event

Illnesses by Pesticide

In Table Two, "Pesticide Associated", *Single Herbicide, Single Fungicide, Single Insecticide* and *Single OP or Carbamate* indicates that only one active ingredient of that pesticide class was in the tank mix; *Multiple Herbicides, Multiple OP and Multiple Fungicides* indicates the tank mix contained more than one active ingredient of that one pesticide class; *MultiOP/Fungicides/Herbicides* indicates two or more active ingredients from different pesticide classes were in the tank mix. Glyphosate, sulfur, metam-sodium/potassium, and propargite were given separate classification since these single materials appeared in relatively greater frequency (more than 3 case associations per year) than other materials. Within the glyphosate numbers, there was no change in the number of eye injuries (4 each year). The increases in glyphosate illnesses/injuries from 1994 to 1998 were from 3 additional skin injuries (from 2 to 5) and 2 additional systemic illnesses (from 0 to 2). The increases in the multiple pesticide (OP/Fungicide/Herbicide) illnesses/injuries were from an additional three skin injuries, 2 eye injuries and 1 systemic illness, compared to 1994. Two of the 1994 sulfur incidents were associated with the physical nature of the material (fine, ignitable powder) rather than its biological activity.

Table Two: Pesticide Associated With Illnesses and Injuries

Pesticide	1994	1998
Glyphosate	6	11
Sulfur	5	5
Metam (Sodium or Potassium)	5	1
Propargite	5	1
Single Herbicide[a]	6	3
Multiple Herbicides[b]	7	5
Single OP or Carbamate (Cholinesterase Inhibitors)[a]	11	13
Multiple OP (Cholinesterase Inhibitors)[b]	7	4
Single Insecticides (Non-Cholinesterase Inhibitors)[a]	6	4
Single Fungicide[a]	5	1
Multiple Fungicides[b]	7	7
Multi OP/Fungicides/Herbicides[b]	0	6
Other (plant growth regulator, fumigant, antibiotic)	2	1
Total	72	62

[a] tank mix contains single active ingredient

[b] tank mix contains more than one active ingredient

A comparison of total production agricultural pesticide use (Table Three) shows an increase, from 175.4 million pounds in 1994 to 198.5 million pounds in 1998. This has been an historic trend in the 90's, with a minor decrease appearing in 1996[3].

Table Three: Pounds of Active Ingredient Used in Production Agriculture

Year	1991	1992	1993	1994	1995	1996	1997	1998
Pounds (x1000)	**132,728**	**156,664**	**172,493**	**175,409**	**187,578**	**182,375**	**189,796**	**199,301**

Illnesses Associated with Equipment and Procedural Failure

Some of the illnesses and injuries could be clearly identified with equipment problems or operator error. Equipment-related problems include design failures (extremely sensitive handwand sprays when dropped, missing gaskets, explosions, valve reassembly allows misassembly, leaking from backpack sprayer vent holes, etc.); system failures (hose rupture, hand gun/hose separation, hose clamp failure); and operator error (failure to depressurize system, dropped container).

Torn or cut water soluble bags (WSB) also led to exposure. Though cutting a WSB is a potential use violation, it was not clear if the bag had been intentionally cut by the MLA or had otherwise been compromised. Since the CAC did not take any enforcement action, it is assumed that the means of the opening of the WSB (cut versus accidentally torn versus defective WSB) was ambiguous.

Several workers handling powder and dust formulations were exposed to airborne particulates when bags were opened or open bags dropped. In these situations, pesticides particulates were able to travel under face shields or safety glasses, causing eye injury. Equipment and procedure related cases are shown in Table Four.

Table Four: Equipment/Procedure Related Illness/Injuries

Error/Procedural Failure Type	1994	1998
Operator Error/Procedural Failure	1	3
Equipment Failure: Hose Failure/Disconnect	6	8
Equipment Failure: Dropped Sprayer (excessively sensitive trigger)	0	1
Equipment Failure: Backpack Sprayer Vent Leak	0	2
Equipment Failure: Other Design Error	3	0
Equipment Failure: Leakage (nozzle/couplings)/Residual Pressure	1	2
Torn/Cut Water Soluble Bag	1	1
Airborne Particulates from Open/Agitated Bags	2	1
Totals	14	18

Regional Distribution of Pesticide Illnesses

Data analysis included regional distribution patterns of illnesses and injuries. The San Joaquin Valley region had the largest number of cases (48 in 1994, 48 in 1998). This may be attributed to the number of pesticide applications made in comparison to other regions. The Central Coast region was a distant second (8 cases in 1994, 10 cases in 1998), with other regions (North Valley, Wine Country, Southern Coast, Sierra, Bay Area, Inland Empire, and Northern Coast) having an insignificant number of cases. There is a difference of one case between years in both the San Joaquin Valley region and the Central Coast region. Identification of what counties were in what region is given in Figure One.

San Joaquin Valley: San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, Kern.

Central Coast: Monterey, Santa Cruz, San Benito, San Luis Obispo.

North Valley: Sacramento, Yolo, Yuba, Colusa, Glenn, Butte.

Wine Country: Napa, Sonoma, Lake.

Southern Coast: San Diego, Orange, Los Angeles, Santa Barbara, Ventura.

Sierra: Mariposa, Tuolumne, Amador, Calavaras.

North Coast: Mendocino, Humboldt, Del Norte

Bay Area: San Francisco, Contra Costa, Alameda, Santa Clara, Solano, Marin, San Mateo.

Inland Empire: Imperial, Riverside, San Bernardino.

Figure One: Regional Map

(Not all counties listed since some had no reported MLA illnesses)

Crop Associated with Pesticide Illnesses

An assessment of crops treated showed that grapes, a major agricultural commodity of the San Joaquin Valley, were the most represented crop associated with MLA illnesses in both 1994 (8 cases) and 1998 (15 cases). In both years fungicides were a major component, and in 1998 the increase may be attributable to glyphosate (2 cases) and insecticides (3 cases). The second most common crop with reported MLA illnesses in 1994 was tomatoes (5 cases), whereas in 1998 it was ornamentals (6 cases).

Agricultural-Industrial Comparisons

The yearly total of pesticide-related illnesses and injuries of mixer/loader/applicators is a relatively small number of cases compared to total nonfatal occupational illnesses and injuries in the California workplace. California's Employment Development Department estimates the

agricultural workforce to be over 400,000[4]; the non-agricultural workforce is approximately 14.5 million[5]. According to the Department of Industrial Relations (DIR), in 1998 there were 9,400 occupational illnesses[6] associated with the following categories:

Occupational skin diseases and disorders (6,700 cases)
Respiratory conditions due to toxic agents (2,400 cases)
Poisoning (300 cases)

These categories approximate the type of illness/injuries associated with pesticide use. However, this includes an enormous number of very diverse industries, ranging from office workers to chemical industry workers. It is difficult to compare the injuries and illnesses between the non-agricultural workforce and pesticide handlers.

In most non-agricultural settings, normal safety practice is to isolate, as much as possible, workers from hazardous materials. Normal agricultural practice for pesticide use is to release the material into the environment, albeit in a controlled manner. The work activity of mixer/loaders/applicators puts them at the potentially highest risk, since they are handling the most concentrated form of the pesticide (mixer/loaders) and are releasing the material within close proximity of their work area (applicators).

Under DIR, there were 18,813 compliance inspections of industrial and office worksites, encompassing 4.4 million workers[7]. In that same time, CAC had conducted 9,181 applicator inspections (with 3,717 findings of non-compliance) and 4,079 mixer/loader inspections (with 883 findings of non-compliance) for a total of 13,260 inspections of the MLA worksites[8]. According to DPR's Licensing and Certification Program, there are approximately 9,000 certified applicators and another 20,000 private applicators (growers)[9]. There is no state tracking system for the number of mixer/loaders.

Discussion

The effect of the WPS on California's agricultural workforce involved in MLA activities is difficult to ascertain. The data set of non-violative MLA illness/injuries does not vary greatly, fluctuating between 60 to 90 cases for the years 1994 to 1998, inclusive[10]. Table One indicates a general reduction in each type of injury (eye, skin, systemic). However, within these categories, there were some interesting fluctuations in the data.

Eye Injury Analysis

Eye injuries where goggles were reported to be worn by the MLA dropped 86% (from 7 to 1). This trend could have resulted from more comprehensive training (including correct goggles donning and explanation of rationale for goggle use) under WPS. Another explanation for this trend is that 1994 eye injuries may have resulted from conditions where improperly worn or defective goggles were used, allowing material access to the eyes. These reasons, however, are speculative.

The increase in eye injury associated with safety glasses use (from 3 to 7 cases) could be related to the use of more comfortable (but less protective) safety glasses versus less comfortable (but tight-fitting) goggles. The cases where safety glasses or face shields were worn, yet injury still

occurred, may suggest an inadequacy in protective value for certain pesticide uses, either from design inadequacies or worker non-compliance. A study of utilization trends in personal protective equipment (PPE) and worker acceptance of eye protection use may be useful to resolve this issue.

The essentially unchanged case numbers associated with face-shield use (3 in 1994, 4 in 1998) suggests that this particular eye protection may not be suitable for some applications. The nature of the face-shield protection (non-sealing, with a large potential exposure route at bottom of the shield) may necessitate a re-evaluation of its use as a sole eye-protection device.

During the 90's protective eyewear manufacturers made great strides in both comfort and aesthetics, both of which greatly influence worker acceptance and compliance. The drop in eye injury in conditions where eye protection is not required (80% decrease, from 10 to 2), may be a reflection of greater worker awareness of potential eye hazards in general, with a concomitant change in eye protective behavior (e.g., voluntary wearing of eye protection).

Dermal Injury Analysis

There were no major declines noted in skin-related injury/illness. A major difficulty in PPE for dermal exposure is that a comprehensive barrier to hazardous materials invariably results in a greater risk of hyperthermia. This is especially true in agriculture, where potential cooling methods (ice vest, vortex tube, suit-refrigeration, air conditioning, etc.) are either encumbering or infeasible.

Systemic Illness Analysis

Cases where routes of exposure were unestablished decreased, from 17 to 6. This may be partially explained by better compliance with PPE requirements stemming from more comprehensive training. Anecdotal information suggests that workers do not always wear PPE properly (e.g. coverall worn but unzipped, gloves repeatedly donned and doffed improperly, respirator improperly seated). This could lead to inaccurate PPE compliance assessment and thus an inability to establish an exposure route (workers often inform the investigator that they were wearing all required personal protective equipment).

Properly trained workers may be more likely to wear PPE correctly. This should lead to less unknown-route exposures, although other contributing factors (e.g. temperature, supervision, length of employment) may influence the outcome of established-route exposures. Established-route exposure largely consists of detecting odor/inhaling mist (inhalation route) or being "splashed" by dilute or concentrated pesticide solutions to the degree that it penetrates the PPE (dermal route). In these cases, either the PPE was not required (no respirator requirement) or it was breached. However, the worker was aware of the condition. In the unknown-route exposures, the worker appears to have no idea of how they were exposed, which may indicate unfamiliarity with PPE function. It may also be explained by a hesitancy to acknowledge that they were not wearing required PPE. Further in-field studies of PPE training and use may help explain and reduce these unknown-route exposures.

Pesticide Analysis

There were no trends identified in the analysis of pesticides involved in the illnesses/injuries. Most categories showed declines, with only glyphosate, single cholinesterase inhibitors (only one OP or carbamate in the tank mix) and multiple mixes (cholinesterase inhibitors with fungicides or herbicides) exhibiting slight increases. As noted earlier, the glyphosate eye injuries were unchanged (4 each year); only the systemic (+2 from 1994) and skin injuries (+3 from 1994) increased. The illness and injury case increase in multiple pesticides (OP/Fungicide/Herbicide) may be an artifact of the data set and the procedure that separates multiple pesticide application mixes from single material applications. In multiples, it is difficult, if not impossible, to determine which pesticide in the mixture was responsible for the illness/injury.

Equipment/Procedural Failure Analysis

Hose failure and disconnection were the leading causes of equipment-related exposure in both 1994 and 1998. In these situations, there was either malfunction of a hose retention system, such as a clamp, or integrity failure of the hose itself. These breakdowns are in high-pressure lines, resulting in uncontrolled spraying of the pesticide. These mechanical failures may be amenable to more diligent equipment maintenance and timely replacement of parts approaching the end of their service life. Replacement of unshielded hoses with steel braided lines, or the use of retention shielding, especially in cases of mix/load/application systems that are used with Category One materials, may reduce or eliminate potential serious exposures from hose rupture. All other exposure modes were infrequent occurrences, though the design flaw of back-pack sprayers which allows leakage through vent holes (2 cases in 1998) should be addressed by a redesign that prevents such exposure.

Conclusions

It appears that the effect of USEPA's WPS on MLA illness and injury incidents in California is difficult to discern. This is not an unreasonable outcome since a worker safety program existed in California previous to the implementation of the federal WPS.

After the WPS was adopted, California initiated an extensive outreach program to ensure workers were adequately trained on new labeling requirements and WPS regulations. The slight reduction in illnesses and injuries could be indicative of this outreach effort with MLA training. Illness data comparing total (not just MLA) pesticide illness cases (with a PISP-defined pesticidal relationship of "Definite", "Probable" or "Possible") of 1994 (448) to 1998 (366) show a significant reduction, but this may be misleading. In both the year before and year after 1998, there were a greater number of cases (545 and 555, respectively). The average cases per year during the past decade (1990 to 1999, inclusive) were 554 ± 100. These data are shown in Table Five[11].

Table Five: Number of Agricultural-Use Pesticide Related Illness in California with a Pesticidal Relationship of "Possible", "Probable" or "Definite"

Year	# of Cases
1990	615
1991	588
1992	651
1993	425
1994	448
1995	655
1996	696
1997	545
1998	366
1999	555

The general reduction of MLA illness may stem from improvements in equipment, greater compliance with PPE use and better training of pesticide handlers. Unfortunately, it could also stem from lower reporting compliance and lack of understanding of pesticide regulations and lack of recognition of pesticide illness/injury by these same handlers.

The following points are recommendations to decrease potential handler exposure events:

1. Compliance and consultation (outreach) programs be continued or developed to ensure the proper and safe use of application equipment and PPE.

2. A focused inspection of mixing, loading and application equipment stressing preventative maintenance being performed on equipment, resulting in less equipment failure accidents.

3. Providing CAC inspectors with continuing education on proper PPE selection, use and limitations (including recognizing PPE that has reached the end of its service life or has been otherwise compromised).

To assist in the implementation of these recommendations, the WHS Branch proposes the following course of action, dependant on available resources:

1. WHS conducted several PPE training programs on respiratory protection in 2001. This effort will continue in 2002.

2. WHS will identify focused inspections of mixing/loading and application equipment in the Enforcement Branch Prioritization Plan with CACs in 2002/03.

3. WHS will develop an education program on proper PPE selection, use and limitations in 2002/03.

4. WHS will conduct an evaluation of PPE use and misuse in 2003/04.

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